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# Correspondence

## The toxicity of Biomite®, GC-mite®, Oberon® and Envidor® acaricides against sugarcane yellow mite, *Oligonychus sacchari* (Acari: Tetranychidae)

**Masumeh Ziaee[1]*, Amin Nikpay[2], Pegah Koohzad-Mohammadi[1] and Solmaz Behnam-Oskuyee[1]**

1. *Department of Plant Protection, Faculty of Agriculture, Shahid Chamran University of Ahvaz, P.O. Box: 61357-43311, Ahvaz, Iran; E-mails: m.ziaee@scu.ac.ir, pegah_mohamadi@ymail.com, s.behnam1394@gmail.com*
2. *Department of Plant Protection, Sugarcane & By-products Development Company, Salman-Farsi Unit, Ahvaz, Iran; E-mail:amin_nikpay@yahoo.com*

* Corresponding author

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Sugarcane is one of the most important industrial crops in Iran and is cultivated exclusively in Khuzestan province in more than one hundred thousand hectares under irrigated system (Sadeghzadeh-Hemayati *et al.* 2011). During planting and vegetative growth of sugarcane, this plant is vulnerable to attack of different pest species including stalk borers (Askarianzadeh *et al.* 2008; Nikpay and Goebel 2016), root feeders and leaf feeders (Taherkhani 2016). Among these pests, mites are important and detrimental for sugarcane growth. Based on Beard *et al.* (2003), there are 30 species of spider mites which attack to sugarcane (interspecific hybrids of *Saccharum* spp.) and its wild races same as several grass weeds. The most important spider mites genus associated with sugarcane is *Oligonychus* spp., and the most notorious species in Iranian sugarcane ecosystem is *O. sacchari* McGregor (Acari: Tetranychidae). Usually, *O. sacchari* infestations occur during late-May until early-August and the severity of damage and scattering of mites are reduced (Askarianzadeh *et al.* 2002). At the beginning stage of mite's activity, early populations may accumulate on grass weeds and early colonization will be occurred underside of leaves. With gradual increase in temperature, the level of damage and population of mites multiply quickly and the infested plant will dry (Fig. 1) (Taherkhani 2016). Under severe infestations, photosynthetic activity was adversely affected, crops appeared colorized, quality characteristics such as purity and stored sugar decreased (Nikpay *et al.* 2016) and eventually the plant growth reduced (Cheraghi *et al.* 2016). Possible control options of spider mites in sugarcane fields are multi-tactics and including biological control (Sarardarzadeh *et al.* 2010), cultural control (Taherkhani 2016), nutritional amendment with silicon by increasing thickness of leaves cuticle layer which lead to reduce in the fitness of leaves for mites feeding (Nikpay and Soleyman Nejadian 2014) and chemical control with synthetic and natural acaricides (Singh *et al.* 2003; Nikpay *et al.* 2012, 2016;). The purpose of this study was to assess the efficacy of four different acaricides against *O. sacchari* under laboratory conditions.

Four acaricides were used in the experiments: Biomite® (Arysta Lifescience, North America); GC-mite® (JH Biotech INC, Canada); Spiromesifen (Oberon® 240 SC, Bayer CropScience) and Spirodiclofen (Envidor® 240 SC, Bayer CropScience).


**Figure 1.** Symptom of damage (A) and population density of *Oligonychus sacchari* on sugarcane (B).

Sugarcane yellow mite, *O. sacchari* population was collected from infested field of sugarcane (CP57-614 variety). A colony of mites was reared on CP57-614 cultivated sugarcane in greenhouse at 32 ± 1°C and 50 ± 5% R.H., with a photoperiod of 16 (light): 8 (dark) hour.

Contact toxicity of acaricides was tested by using leaf-dip technique with some modification (Hamedi *et al.* 2011). The concentrations of 1, 1.5, and 2 lit/ha were applied for Biomite® and 0.3, 0.5 and 1 lit/ha for GC-mite® (Nikpay *et al.* 2016). For Oberon® and Envidor® recommended concentration of 0.5 lit/ha was applied for the experiments. Leaf discs (3 cm diameter) of CP57-614 variety were dipped in acaricide solutions for 10 seconds and allowed to dry for about one hour. Control leaf discs were dipped in distilled water. Fifteen less than 24-hour-old unmated female and male of *O. sacchari* were obtained from colony and placed on the dorsal side of sugarcane leaves using a fine soft pointed brush. A thin wet cotton layer was located at the bottom of Petri dishes and the leaves were placed on them. Petri dishes were covered with a ventilated lid and each concentration was replicated six times. Mortality was counted after 24 and 48 hours. Mites were considered dead if they failed to move for a distance, lost their balance during movement and turned upside down.

Other experiments were conducted to assess $LC_{50}$ values of acaricides contact toxicity against *O. sacchari*. Pre-test experiments were carried out to determine a range of doses that cause 20–80% mortality. For each acaricide, concentrations were selected in the symmetric five-dose design (Robertson *et al.* 1984). The concentrations were 1, 1.25, 1.5, 2 and 2.5 lit/ha for Biomite®; 0.3, 0.45, 0.65, 1 and 1.5 lit/ha for GC-mite®; 0.12, 0.25, 0.45, 0.8 and 1.6 lit/ha for Oberon®; and 0.1, 0.3, 0.5, 0.75 and 1 lit/ha in the case of Envidor®. The conditions of the experiments were as above experiment. The mortality was checked after 24 hours of exposure. All experiments were conducted in an incubator with the following conditions: 28 ± 1ºC, 50 ± 5% R.H. and a photoperiod of 16 (light): 8 (dark) hour.

For the first experiment, mortality was corrected using Abbott formula (Abbott 1925). The percentage of mortality was transformed to square root of arcsine to normalize the data, but non-transformed data are presented in tables. The data were analyzed using Analysis of Variance (ANOVA). For Biomite® and GC-mite®, means were separated by Tukey multiple range test and in the case of Oberon®and Envidor®, t-test was used for mean comparison at $P = 0.01$ using SPSS software. Obtained data from dose-response bioassay curve were subjected to Probit analysis (Finney 1971) to estimate $LC_{50}$ values and their confidence intervals were calculated using SPSS version 16 (SPSS 2007).

The effect of different concentrations of Biomite® against *O. sacchari* is presented in Table 1.

**Table 1.** Mean percentage mortality ± SE of *Oligonychus sacchari* exposed to different concentrations of Biomite®.

| Concentrations (lit/ha) | Exposure time (hours) | | $t_{10}$, $P$ |
|---|---|---|---|
| | 24 | 48 | |
| 1 | 41.1 ± 2.1 b | 58.9 ± 2.7 b | 5.3, 0.000** |
| 1.5 | 64.4 ± 2.2 a | 72.2 ± 4.0 a | 1.7, 0.120$^{ns}$ |
| 2 | 70.0 ± 3.3 a | 83.3 ± 2.8 a | 3.03 , 0.013* |
| $F_{2,15;}$ $P$ | 34.82, 0.000 | 14.33, 0.000 | |

Means followed by the same letter in each column are not significantly different using Turkey's Test at $P < 0.05$.

There was no significant difference between 1.5 and 2 lit/ha concentrations at two exposure times. The mortality was 64 and 70% after 24 hours of exposure which exceeded to 72 and 83% after 48 hours, respectively. The mortality increased with increasing in time of exposure except for the concentration of 1.5 lit/ha. The acaricidal efficacy of GC-mite® is shown in Table 2. The higher concentration, 1 lit/ha, was significantly more efficient than 0.3 and 0.5 lit/ha of GC-mite®. The mortality was 51% after 24 hours of exposure and reach to 63% after 48 h interval. The mortality increased with increasing in time of exposure except for the lowest concentration of 0.3 lit/ha. The mortality of *O. sacchari* adults exposed to both formulations (Oberon® and Envidor®) increased with increasing in time of exposure from 24 to 48 hours. There was no significant difference between the efficacy of Oberon® and Envidor® after 24 hours of exposure. However, the acaricidal toxicity of Oberon® increased significantly after 48-hour time interval (Table 3).

**Table 2.** Mean percentage mortality ± SE of *Oligonychus sacchari* exposed to different concentrations of GC-mite®.

| Concentrations (lit/ha) | Exposure time (hours) | | $t_{10}$, $P$ |
|---|---|---|---|
| | 24 | 48 | |
| 0.3 | 18.9 ± 4.3 b | 33.3 ± 5.1 b | 2.1, 0.058$^{ns}$ |
| 0.5 | 32.2 ± 2.6 b | 48.9 ± 5.6 b | 2.7, 0.023* |
| 1 | 51.1 ± 4.0 a | 63.3 ± 6.6 a | 3.6, 0.005** |
| $F_{2,15}$ $P$ | 18.3, 0.000 | 14.40, 0.000 | |

Means followed by the same letter in each column are not significantly different using Turkey's Test at $P < 0.05$.

**Table 3.** Mean percentage mortality ± SE of *Oligonychus sacchari* exposed to recommended concentration (0.5 lit/ha) of Oberon® and Envidor®.

| Acaricide | Exposure time (hours) | | $t_{10}$, $P$ |
|---|---|---|---|
| | 24 | 48 | |
| Oberon® | 33.3 ± 1.7 | 47.7 ± 2.0 | 5.3, 0.000** |
| Envidor® | 27.2 ± 3.6 | 37.7 ± 2.2 | 2.4, 0.040* |
| $t_{10}$, $P$ | 1.38, 0.196$^{ns}$ | 3.30, 0.008** | |

Based on $LC_{50}$ values, GC-mite® was the most effective acaricide against *O. sacchari*. Relative potency ratio of GC-mite® compared to the other tested acaricides indicated that GC-mite® was 1.17, 1.15 and 2.01-fold more toxic than Biomite®, Oberon® and Envidor®, respectively (Table 4).

Our results showed that all tested acaricides were effective against *O. sacchari*. Nikpay *et al.* (2016) stated that Biomite® and GC-mite® could significantly reduce the population of *O. sacchari* three days after application of acaricides on CP48-103 and CP57-614 varieties. The population of mites increased after 30 days of application, but at the highest dose of acaricides, they were more effective than control. However, under field conditions the lower dose rates of Biomite® and GC-mite® could not control in satisfactory level and this was ascribed to high temperature during experiments. In a recent study, Arbabi *et al.* (2015) assessed the effects of different control methods including water spray and acaricides for management of *O. sacchari* on two sugarcane varieties.

The results showed that both control methods had significant differences versus control, although the effects of chemical control by fenpyroximate 25 days after treatment was significantly better than water spray.

**Table 4.** $LC_{50}$ values of *Oligonychus sacchari* exposed to different acaricides after 24 h interval (df = 3).

| Acaricide | $LC_{50}$ (lit/ha) | CI (lit/ha) | | Slope ± SE | Chi-square | *P* value | Relative potency (CI) |
|---|---|---|---|---|---|---|---|
| | | Lower | Upper | | | | |
| **GC-mite®** | 0.86 | 0.73 | 1.07 | 1.66 ± 0.25 | 0.45 | 0.30 | - |
| **Biomite®** | 1.01 | 0.81 | 1.22 | 1.72 ± 0.25 | 0.63 | 0.73 | 1.17 (1.10–1.14) |
| **Oberon®** | 0.99 | 0.80 | 1.32 | 1.51 ± 0.18 | 1.71 | 0.63 | 1.15 (1.09–1.23) |
| **Envidor®** | 1.73 | 1.15 | 3.89 | 1.11 ± 0.21 | 2.52 | 0.47 | 2.01 (1.57–3.63) |

CI: confidence interval.

The use of chemical pesticides to control and reduce sugarcane mite population has long been common. Singh *et al.* (2003) evaluated chemical control of Endosulfan 35EC, Monocrotophos 36EC, Dichlorvos 76EC, Quinalphos 25EC, Nethrin (each with 1.25 lit/ha) and Lime sulphur on CoS767 variety under 3-year field trials. Their results indicated that Nethrin and Lime sulphur were more effective than other chemicals and significantly reduced population of mites. Arbabi *et al.* (2013) investigated the efficacy of Biomite® EC, Envidor® SC 240, Fenpyroximate SC 5% and EC 5% and Etoxazole SC 10% on *Tetranychus urticae* Koch and *Panonychus ulmi* (Koch). They concluded that high density of mites' population was observed in Biomite® treatment.

The results of our study revealed that application of plant-based acaricides could reach satisfactory level of mite control and these compounds as well as chemical-based acaricides may applied as a part of integrated mite management strategies under sugarcane fields.



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